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ABSTRACT

The reason for creating this resource was to produce a booklet that was concise and reflected the character and uniqueness of Vermont schools and, at the same time, reflect the ongoing nature of the curriculum improvement process. This document was intended for schools and districts in all phases of curriculum improvement, from creation through implementation to the assessment of program effectiveness. This guide describes how to implement effectively the programs that work with the Vermont Framework. From laying out a template for the process to supplying descriptive vignettes about schools immersed in change, this guide can help schools seeking to implement meaningful curriculum reform. (ASK)



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1

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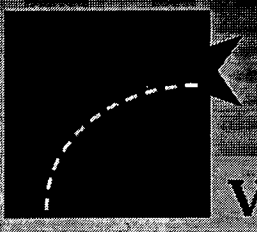

VISMT

# A *Guide* *for* LOCAL STANDARDS-BASED *Science Curriculum*

2

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# A Guide for Local Standards-based Science Curriculum

## Table of Contents

# Introduction

Many schools and teachers have asked for guidance in producing a science curriculum which would effectively guide classroom practice. There are currently a number of good books available to guide this process, many of which are listed in the Resources Section. Our intention in creating an additional resource was to produce a booklet that was concise and reflected the character and uniqueness of Vermont schools. At the same time, we strove to reflect the ongoing nature of the curriculum improvement process. This document was intended for schools and districts in all phases of curriculum improvement, from creation through implementation to the assessment of program effectiveness.

A few key concepts have become clear to us. First, the changes incorporated embodied the standards-based movement and the Vermont Framework of Standards and Learning Opportunities are significant. All teachers and support personnel responsible for science instruction need to understand these.

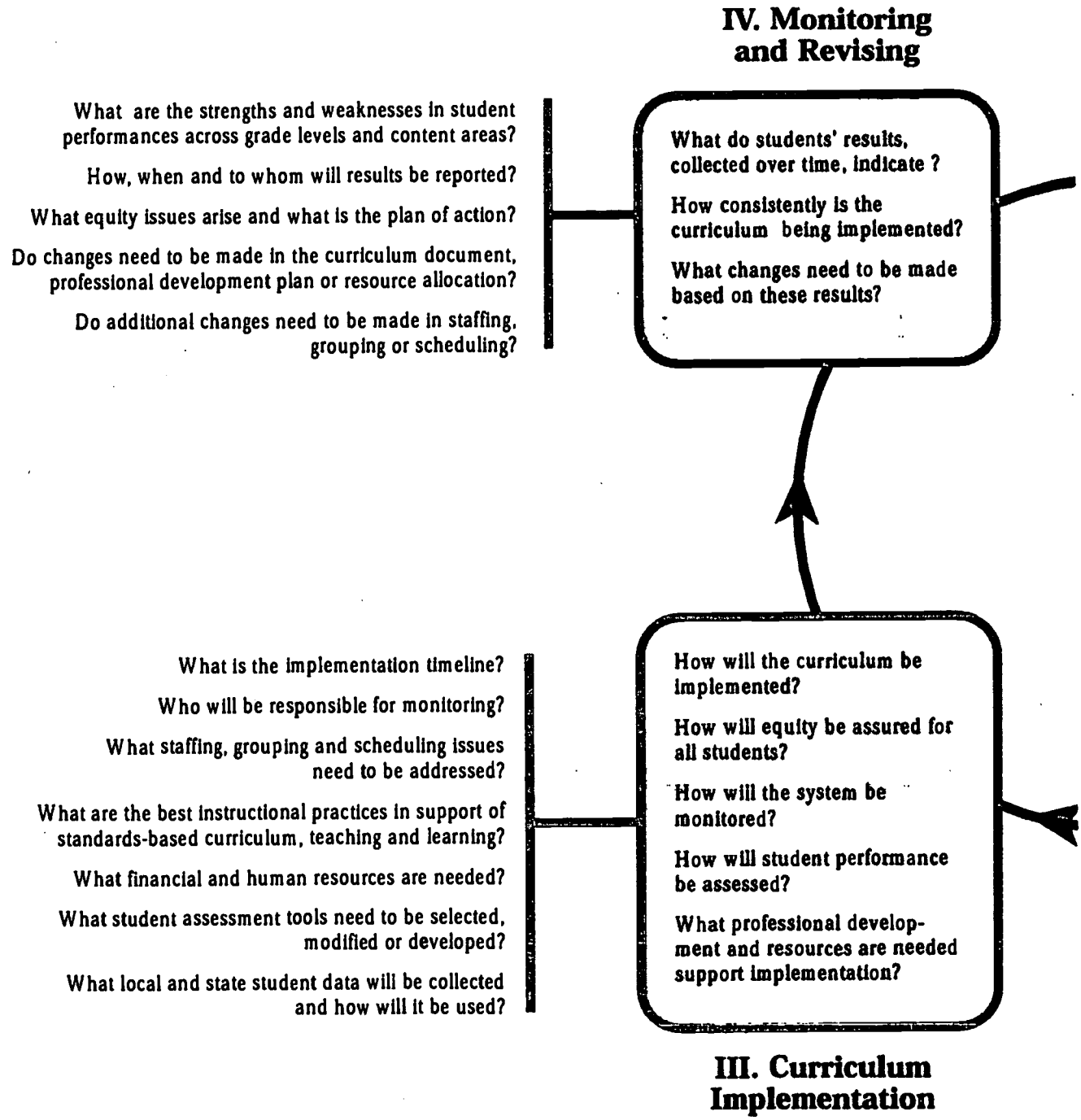
Second, change is usually challenging. Success in making change is a function of proper guidance, feedback and human support. Adequate professional development is essential. To support the changes to standards-based instruction requires a multi-year multi-faceted professional development plan.

Third, published teaching materials can play an important role. Early in the curriculum-building process they can provide a useful vision of the ways others have conceived of the standards in practice. Later, during the development phase, published materials can ease the burden of lesson plan development and provide uniform consistency and quality between and across grades.

Fourth, time is an essential factor. None of the suggestions in this booklet can be implemented in "short order." They require care, testing, discussion, and thought. Schools and districts must accept this and give the consideration necessary to produce an excellent, long-lasting result.

These preliminary thoughts, along with the school stories recounted in this booklet, should help get you started on the pathway to excellent curriculum.

# Curriculum Development



# and Revision Cycle

## I. Laying the Groundwork

Why change?

What is the structure and process needed to complete the curriculum work?

What resources are available?

- What is the data telling us about performance of all students in relation to the Vermont Framework?
- What is currently being taught and assessed?
- What needs to be taught and assessed?
- Who will do the curriculum work and when?
- How will the work be organized: what is the committee structure and timeframe for this process?
- What expertise does the staff have?
- What training is needed?
- What resources will be needed: time, money, leadership and expertise?
- How will stakeholders stay informed and contribute to this process?

## II. Research and Development

What is the vision of science education?

What components need to be included in the curriculum document?

How will the curriculum document be formatted?

How will published standards-based programs/ materials be included in the curriculum?

- How will guiding principles, research-based best practices, and opportunities to learn be embedded in our curriculum?
- How can other curriculum models, materials, resources be helpful?
- How will published standards based materials be used? What other curriculum resource materials will be needed?
- What program and system standards, assessment tools, benchmarks and/or profiles are going to be included in the curriculum document?
- How will the curriculum be piloted and evaluated?
- What professional development will be needed to pilot the curriculum?

# Actions

## I. Laying the Groundwork

- Establish a Science Curriculum Leadership Team to Work with all stakeholders.
- Assess leadership team members for their understanding of the Standards. Identify resource(s) needed to increase the teams' knowledge of the purpose, role, and use of the Standards.
- Identify what is currently being taught at each grade level in all buildings, standards that are being addressed and assessed, standards that are missing, and instructional approaches utilized.
- Analyze student performance data. What does it say about the performance of all students in relation to the Vermont Framework?
- Interpret and communicate information learned from curriculum and data analysis to all stakeholders
- Develop a strategic plan for all phases of curriculum work: a time line ( writing , implementing, monitoring and evaluating), an assessment of teacher and professional development needs, a resource budget for each phase, pro-active strategies for dealing with anticipated challenges, and communication processes for all stakeholders

## II. Research and Development

- Engage the leadership team (and staff) in professional development activities to increase their knowledge of the purpose, role, use and understanding of Standards.
- Develop or revise the vision and goals for the science curriculum.
- Review resources (see Resource Section of booklet)
- Select the components and format to be used in the science curriculum, e.g., philosophy, vision, benchmarks, pedagogy, assessment tools
- Determine the standard and evidences (concepts, skills and processes) to be taught and assessed at each grade level.
- Submit the first draft of document to experts (scientists, science educators etc.) for review of content accuracy.
- Select teachers to revise, develop and/or purchase published materials to be piloted.
- Revise the curriculum accordingly

## III. Implementation

- Provide teachers with multi-faceted professional development (modeling, peer coaching, mentoring, content enrichment) that is linked to the curriculum and strategic plan.
- Make necessary schedule changes to support implementation of the curriculum
- Provide teachers with time and opportunities for solving problems related to curriculum issues.
- Develop and revise assessment tools to monitor curriculum effectiveness
- Maintain a focus on the curriculum implementation process
- Align policies to support curriculum goals

## IV. Monitor and Evaluate

- Review all program data on a regular basis.
- Make recommendations for revisions
- Communicate results and recommendations to all stakeholders
- Assess the effectiveness of the curriculum process and products over several years
- Begin the revision cycle.

# Finding Your Way Through The Curriculum Maze

Those of us who have lived and worked in Vermont schools for some years have learned how to make do in less than ideal circumstances. Although we might not be blessed with monetary wealth, we do have creative, empowered teachers who care about our students. We tend to find a way to do things against all odds.

Our supervisory union, like many others in our state, does not have a curriculum coordinator because of costs. Any curriculum work must be lead and designed by teachers. Part of our struggle in making a curriculum was finding a process that would work in this situation. We learned so much that the story is long. To help the reader, essential elements for curriculum development are italicized.

As we began the process of revising our K-8 science curriculum, teachers were told they would receive stipends for this work. Curriculum work is very demanding and time consuming. In talking with teachers from other schools, we learned that doing this work without stipending teachers is unlikely to meet with success.

**Preparation:** Teachers from the elementary schools who had participated in a three-year, NSF-funded science program at UVM were elated at the thought of developing a new curriculum. This course had changed our science instruction dramatically. We felt more comfortable with science content and were no longer satisfied with classroom lessons that did not offer students opportunities to construct their own meaning and challenge false assumptions or concepts. We were not teaching from the existing curriculum and were more than ready to revise it. After going through this process we realize committee members must have the necessary knowledge in science content, processes and best practices.

***After going through this process we realize committee members must have the necessary knowledge in science content, processes and best practices.***

Since our work started prior to distribution of Vermont's Framework of Standards & Learning Opportunities, we began the process using the National Science Standards and Vermont's Common Core. For many on the committee, this was their first time reading these documents. At the time, we didn't realize this was a potential problem: ideally all committee members should have a deep understanding of the standards they are using. Professional development should be provided if committee members do not have a comfortable working knowledge of standards and best practices.

***Professional development should be provided if committee members do not have a comfortable working knowledge of standards and best practices.***

**Phase One:** The committee felt we needed to gather data to find out what was currently being taught at each grade level in the schools. We developed a survey that listed standards for grade levels, and asked every teacher to check off the ones they were currently addressing and assessing. Teachers were also asked to list the science topics or themes taught each year. With an 80% survey return rate, we had a strong sample size and information about the curriculum currently being implemented. The committee then compiled, graphed, interpreted and published this information. The information was very revealing. It was presented to the principals and school staffs.

With the survey, we were able to document what we suspected: we were lacking consistency and had gaps in our current science program. For instance, environmental and ecological principles were being taught in every grade, but key concepts in physics were never addressed. We also found that science learning wasn't being assessed well at the elementary level. This information helped create an understanding of why we would need a curriculum that would clearly delineate by grade level which key scientific principles and concepts would be taught. The survey and analysis process we used is called curriculum mapping (for a sample, see page 27);

done this way it lays the groundwork for the work ahead and helps everyone understand the current state and the rationale for change.

**Phase Two:** From the next meeting on, our working group became very small. The reason for this was unclear at the time, but in hindsight, I believe it was due to people's lack of familiarity with the standards.

We were down to four core members. Three of the four elementary schools were represented along with the chair of the high school science department. We met to develop a plan. Some of us spent the summer locating and reading articles and books to gain the knowledge we needed. We then set a schedule to meet once a month during the school year. We found it was important to create a plan for the entire process in order for people to gain an understanding of what would be required of them. One component of this process involved developing a vision for a quality science program and deciding on format. This really tests a groups' resolve but is a vital stage. For larger groups, a facilitator might be necessary to successfully move the group through the process.

**Phase Three:** We began our monthly meetings in September of 1996. We met during the school day when our minds were fresh and we could spend large blocks of time together on revisions. Committee members were granted release time from their individual schools. One committee member was, by this time, a VISMT Teacher Associate and able to provide the group with additional resources.

***Curriculum must cover more than content***

Since the Vermont Framework of Standards and Learning Opportunities had recently arrived in all schools, and assessments were going to be based on this Framework, we decided to directly reference these standards in our curriculum. We struggled with format. We asked ourselves what else should be included in the curriculum.

We wanted the curriculum to:

- be easy to follow
- articulate the standard and evidence that would be assessed at each grade level
- zoom in on the evidence and clearly state at the local level what students should know and do
- include the standards from the Vital Results section of the Framework so the curriculum would cover more than content
- embed the inquiry process in every standard
- reflect varied instructional strategies and encourage student use of scientific tools and equipment
- address different levels of understanding and respond to individual student interests, strengths, experiences and needs
- be flexible so teachers could create their own standards-based units, and use published programs, along with other quality resource materials
- provide teachers who participated in the three-year NSF program and other science workshops a way to share their knowledge and materials
- have student benchmarks and assessments in the document
- embed professional, program, and system standards

**Phase Four:** In the process of alignment, we pulled together all our resource books, other drafts of curriculum, scope and sequences of published programs, internet sites, etc. These materials could be easily shared among a group of four. Each of us selected the content standard that we felt was our area of strength and wrote the curriculum for grades K through 6. This work was done independently, on our own time.

Day meetings were spent updating each other on work done independently, making group revisions, checking for alignment, identifying gaps, and checking for developmental appropriateness of content at specific grade levels. The high school science teacher checked for content accuracy. We also tried to make natural connections between topics within and between grade levels, keeping in mind field-work and design technology projects that could be integrated.

***[The superintendent] sent a clear message to building level principals throughout the curriculum development process that all teachers would be expected to implement this curriculum.***

**Phase Five:** In May of '97, the draft was ready to be printed and distributed to schools. The writing process had taken nine months. When we began this process, we underestimated the task at hand and the time it would take. Even though we had created the format early on, we spent a lot of time trying to develop consistency between writers so the document would flow.

A little over a year had passed since our first science curriculum meeting. We maintained communication with our superintendent through the committee chair and individually via e-mail. He had sent a clear message to building level principals throughout the curriculum development process that all teachers would be expected to implement this curriculum. Teachers were encouraged to talk to building-based committee members about the work being done. All the administrators supported the work by providing their committee members release time

once a month. This support and patience was critical to the process.

**Phase Six:** Once the K-6 curriculum was written, it was time to work on extending it through grades 7-12. The middle and high school science teachers met with the K-6 curriculum committee chair in the summer to begin aligning their science curriculum. This too was a critical component. The committee chair and high school teacher who had been part of the process from the very beginning were able to guide this group through the same process. They worked for one week together and agreed to work independently to finish writing the curriculum. By the fall of '97, the document was ready for group revisions. The curriculum was distributed early in '98. This grade 7-12 document follows the same format as the K-6, so it is easy for teachers of any grade level to know what is being taught at other grade levels.

***Without a strong monitoring and evaluation system in place, this document could very well end up suffering the same fate of many other curriculums — lying dormant on bookshelves***

**Phase Seven:** The K-6 curriculum is now being piloted during the '97-'98 year. Since many teachers were implementing new math curriculum that year as well, they were encouraged to pilot those pieces they were most comfortable doing. Some teachers began piloting published programs. At the end of the year we compiled a list of published programs available for each grade level. We also surveyed teachers to determine which pieces were taught, what programs and materials were used, what standards-based units and assessments were created, what issues, concerns, and professional development needs must be addressed. With this information, we will plan professional development opportunities for the '98-'99 year and refine the curriculum itself.

**The Future:** Next year, teachers will be expected to implement the curriculum. The science curriculum committee will meet with administrators to develop a plan for monitoring implementation and evaluating the curriculum itself. We will need to make sure necessary resources are allocated for professional development and the purchasing of supplies and equipment for more than one year. We will need to talk about ways teachers can share units, assessment tools, materials and knowledge frequently throughout the year. Many teachers are not aware of the current standards-based published materials, so we will need to decide a process for teachers to pilot these programs.

Without a strong monitoring and evaluation system in place, this document could very well end up suffering the same fate of many other curriculums — lying dormant on bookshelves. Implementation is a critical phase for the committee to work through. It is important that this curriculum be part of every child's education at every level in every school.

It is clear to us now that we should have paid more attention to published standards-based programs throughout the writing phases. We were casually referring to them as we were writing, but had we been more intentional, we could have created a direct link in our curriculum for programs that teachers could utilize at each grade level. We had to go back and match programs with grade levels. We were able to do this in most areas but we still have some fine tuning to do.

***It is clear to us now that we should have paid more attention to published standards-based programs throughout the writing phases.***

We definitely used a constructivist approach for designing our curriculum. We spent a great deal of time exploring, investigating, and designing the curriculum. We grappled with interpreting and internalizing Vermont's Standards. We became familiar with, and used, many types of resource materials to support our work. We occasionally took a different path than we had originally intended to find answers to our questions. We experienced "Aha's" and made new discoveries. We corrected each other's misconceptions and verified each other's findings.

We know if the curriculum is alive, then the work is always evolving, improving, but never done. As we continue the work of improving our science program, there will always be more questions to ask, more information to be gathered, more revisions necessary.

# How to Create an Exemplary Shelf Document

*Or what not to leave out of the curriculum development process*

During the summer of 1993, I was hired by my small rural school to write the K - 6 science curriculum, a task scaled down from the original "mission impossible" of single-handedly writing K -12 math and science! I set about this assignment by immersing myself in every available standards document, current research articles on science education, sample curriculum documents, science content books and teachers' science resource books.

Through that research, I developed a framework organized around major themes such as flow of energy, structure and function, interactions of systems and diversity. one global, unifying concept in each of the sciences for K - 6 was identified. (For example, the unifying concept in Life Science was: Living Beings are diverse and interdependent. Their interdependence involves continual cycles of exchange of matter and energy.) Grade-level focus questions and content were then elaborated within this structure. This framework was designed to help students develop major understandings through conducting scientific inquiries. It is rich in content but not overstuffed with an excess of minute facts.

Although I was hired to do the job alone, I was able to bounce ideas around with colleagues from my school and with higher-education science professors who took part in the first VISMT Summer Institute. This dialogue was not only valuable, it was inspirational and indispensable in creating a comprehensive, yet manageable curriculum document.

***Unfortunately, the implementation phase was not nearly as well thought-out as the development phase.***

Unfortunately, the implementation phase was not nearly as well thought-out as the development phase. We had a wonderful, but brief, inquiry science activity at our back-to-school inservice, after which I gave an overview of the new science curriculum. There was one other one-day inquiry science workshop later that fall, but no other follow-up or support provided for staff who were already somewhat overwhelmed by the numerous restructuring endeavors underway. I returned to my fourth grade classroom and attempted to collaborate and support others in understanding and using the curriculum, but there was no organized, concerted effort in that direction. As a result, implementation of the curriculum was uneven. Although it may be an exaggeration to call it a shelf document, there are definitely parts that haven't fully come to life in the classroom.

A few cautionary words for schools that don't want to see their hard work end up in a forgotten, dust-collecting binder on a shelf: in addition to the all-important process of developing an engaging, rigorous, standards-based science curriculum and related student assessments, be sure to include a timeline for piloting, revisiting, and fully implementing the curriculum, along with a plan for ongoing professional development in science content and science education.

# One Small School's Story of Curriculum Development

The process of developing a science curriculum began at our school in 1993, and continues to evolve . As we have worked on curriculum, the teachers and other stakeholders realized there are gaps and more work is needed. They have also realized that their curriculum is not, and will never be, a traditional curriculum.

Along the way, they also realized some crucial aspects of curriculum development which have helped make this process work. One key aspect is the involvement of all stakeholders: teachers, administrators, and community. Another aspect is the necessity for strong supports during the process, including materials review, research, budgeting and unit development. And most important of all, professional development for teachers.

***Most important of all, [is] professional development for teachers.***

The timeline here focuses on the professional development aspect of an evolving science curriculum, in hopes that other schools will offer equally strong support.

**Summer 1993:** all staff participate in a Foodworks course: The very first step for our school was to create a common vision together. The Foodworks/Common Roots approach enabled us to create a K-6 "journey" that included rotating integrated science and social science curricula. Based on gardening, the natural environment and schoolyard habitats, our curriculum approached science and social studies in a way that we felt offered our students a world view. We implemented the curriculum in September 1994.

**Summer 1994:** focus on science content at the VISMT summer institute: After our first year, we realized we needed professional development in science content and process, and decided to focus on physical science. Five of us, teachers, principal, superintendent and even a school board member, attended courses including one on the physics of fluids, taught by Gregg Humphrey and Maura Carlson. This was a great success and helped us with science teaching all year.

**Summer 1995:** Continuous Assessment in Science Project Institute: We were gaining content and process knowledge, and becoming much more comfortable with inquiry science. Two of our staff were invited to be part of an action research project that focused on continuous assessment in science. Through this involvement , we were lucky enough to have Gregg and Maura as mentors in our work. Mentor support included site visits, model teaching and co-teaching. This enabled us to continue to make progress and implement our learning in the classroom. Not only were the summer institute participants learning, but other teachers in the school were able to benefit from our experience. After this summer, we realized that additional science materials were necessary. The school board approved expenditures for these, which gave us both materials and a sense of support.

***Mentor support included site visits, model teaching and co-teaching.***

**1996:** More involvement in professional development, and we start writing! Two more of our staff became involved in the Continuous Assessment in Science Project. At this point in time, we began writing our tentative plans for the science curriculum. We selected three or four topics for each grade year and aimed to cover all strands in physical, life and earthscience. Because we have a multi-age configuration, we developed this topic list in three year cycles with science units developed for each multi-age group. We selected and purchased modules such as materials from Insights and GEMS to supplement teacher-developed materials. We piloted the plan in September.

At the same time, three of our group participated in a course on Standards and one of those three teachers worked on Advanced Inquiry at the Exploratorium. We were reaching out, broadening our understanding, and making certain that all the critical factors for science curriculum (grades K-6) were included.

**School year 1997:** Incorporating the Standards: Over the year we studied our topic lists and began to look

at our units with an eye to Standards and Learning Opportunities. One of us became involved with the Discover Earth project, a NASA project focusing on Earth systems. This offered us a look at Earth Science. By this time we had evolved to the point where one teacher attended the Institute and brought the materials back to the rest of us.

**The Work Continues, 1997:** This past fall we began a curriculum-mapping process in science which we will do three times a year during assessment periods. We ask these questions: What have you taught in science since the last mapping? Which standards did you address? Which standards did you assess? Describe the assessment and the tools used. With this information, we can begin to show everyone what is actually being taught in science at our school, make sure that the standards are being covered, and that all topics are well-addressed.

When we meet to do this work, we have 2-3 hour meetings and augment our work with courses each of us takes. Each teacher is examining the topics they cover and entering a dialogue with others about the plan and how well it works for us all.

We are trying to decide what additions, deletions and movements are necessary to improve the plan, asking the questions listed above. We are trying to be very careful to have a clear dialogue, use the Framework as our guide, and focus on concepts and skills.

***Our curriculum document is part of a cycle of professional development, trial, reflection, continuous improvement and review.***

After individual teachers have done this, we will get together again to discuss, review and revise the plan. We will elaborate on the topic list and ask these questions: What does it mean to teach science in the Multi-age class? What are kids actually doing and learning in each unit? Which Learning Opportunities and best practices are you using? What teacher-designed materials do you use to teach these units? What published materials do you use?

In this analysis we will look at potential new materials, review our current assessments, examine other available materials and assessments, and continue to write our curriculum. In all cases, we want to articulate the assessments at each grade level and know what specific assessments we are using for each evidence in the Framework.

Our goal is an articulated science curriculum. We continue to prepare ourselves for it through continuing professional development and through a shared process of development. The more tools and skills we gain, the more we realize that our curriculum will never be a "finished product," but rather a living, breathing document continually revised to meet our needs and our students' needs. Our curriculum document is part of a cycle of professional development, trial, reflection, continuous improvement and review. The best way to "see" our science curriculum is to come to our classrooms and see it in action! Contact VISMT for information.

# Published Curricula as a Catalyst

The introduction of the D.A.S.H elementary science program provided a tremendous impetus for the implementation of an articulated standards-based science program in my district's two elementary schools. The process was also testament to the value of a teacher leader in the area of curriculum reform.

Efforts to change the science curriculum began in 1991 when a supervisory-union wide science curriculum was developed and endorsed. Teachers from each school in the supervisory union attended meetings with a science consultant from a nearby university to develop the curriculum. Copies of the resulting document were then bound and distributed to every classroom teacher in the district. The teacher representatives were charged with leading local presentations and discussions of the new curriculum at each of their respective schools. Workshops were also offered at each site in order to assist with the adoption of the curriculum.

This process was in the "copy and distribution" stage at the time I joined the school as its new (and first full-time) principal. I participated in all the local and supervisory union workshops and discussions and helped our teachers review and assimilate the curriculum, design and model units of study, and work together to web the components into a coherent continuum. Under the leadership of respected local science instructors, we practiced active exploration, science process skills and cooperative learning.

Teachers were clearly working hard to implement this curriculum as effectively as possible, yet I could see that this was a very labor-intensive process for any school to undergo and that full and confident implementation of this curriculum was quite some time away. I knew that our conscientious classroom teachers were concerned as well.

In the winter of 1993 I learned about the D.A.S.H K-6 science program, a published science curricula. The D.A.S.H philosophy was a good match with the mission of our school and our newly designed curriculum. There is no doubt that finding time is a challenge for all teachers, but a special challenge for those in small schools where there are fewer members to share the many roles and responsibilities. In that sense, a published K-6 articulated program offered great appeal to our small school. With that incentive, our third grade teacher asked to take part in a training offered nearby. I was in full support of her request. She returned in August after the training full of the resolve necessary to begin implementing the program in her classroom and, she hoped, the school.

This teacher's enthusiasm for the program combined with the students' eager engagement in 'doing science' provided the most potent fertilizer for growth of the program among our other teachers. She shared her support of the program at our staff meetings, invited teachers to come and join her in the lessons in her classroom, and joined with our full teaching staff as we interfaced the D.A.S.H continuum with our supervisory union science curriculum.

***Teachers were clearly working hard to implement this curriculum as effectively as possible, yet I could see that this was a very labor-intensive process for any school to undergo and that full and confident implementation of this curriculum was quite some time away***

We received further incentive to expand the program in the school when we learned that it was among the programs that VISMT felt represented good standards-based science instruction. With those sources of encouragement combined with clear administrative support, the teachers in many of our other classrooms participated in a subsequent training and implemented the program in their classrooms. The program has spread. Although there are still some classes to be involved, there is a strong and sincere schoolwide commitment to integrate D.A.S.H throughout every classroom. We realize that even though we will soon have a common curriculum being taught throughout the school, there is still work to be done. Our teachers have indicated that they need professional development in some of the topics addressed in the

Standards. We will need to find resources and time to make this happen. Part of the professional development might take the form of identifying books and articles. Another piece might be using outside training. We hope we can locate training that addresses our content needs while at the same time providing at least some of the instruction in a manner consistent with the pedagogy we use in our classrooms.

Another focus will be in assessment. In the fall we will be using information derived from the state science assessment to further refine our program's alignment and to address shortfalls indicated by the data. Because the science assessment data is only available at one grade level we would also like to better track our student performance through the development and use of grade level assessments. It is a large task. Our hope is to complete this project in conjunction with other D.A.S.H. schools. It makes little sense, with everyone as overscheduled as they are, for schools to work on common needs in isolation.

***It makes little sense, with everyone as overscheduled as they are, for schools to work on common needs in isolation***

# The Morristown School District's Curriculum Improvement Cycle

*"A Work in Progress"*

The title of this piece gives some insight into the instructional improvement process that has evolved in our school system. For a number of years, our school district has been involved in a series of education reform efforts designed to improve student learning. Our staff has always been willing to venture into new terrain because they want the best education possible for their students. Embracing our systems vision statement " A Community of Learners with the Courage to Grow", the staff has demonstrated the willingness to make difficult changes in order to ensure student success.

Because of this unwavering willingness to strive for excellence, our school district became a full partner in the New American School Reform Initiative. We agreed to be on the cutting edge of much needed school reform and consequently we pushed ourselves toward the goal of accelerated system-wide improvement. Experience provides perspective. We learned that one of the harsh realities that comes with being on the cutting edge, is that it's difficult to find models that will help show you the way. You quickly recognize that you must be ready to adapt as you travel down this new path of systems change. With that as a context, we are pleased to share what we are learning.

***We learned that one of the harsh realities that comes with being on the cutting edge, is that it's difficult to find models that will help show you the way.***

As we took a hard look at our instructional program, it became clear that we needed an in-depth process that would help us in the development, implementation and on-going evaluation of our instructional efforts. Consequently, we incorporated the National Alliance process, the five essential design tasks, and we mobilized all faculty and staff in pursuit of this work. When Vermont made the decision not to continue with the New American Schools Partnership, we recognized that it would not, nor could not, stop our quest for excellence in our schools. We simply pushed on and tried to utilize what we had learned from our alliance activities.

As you may know, our school district was one of the first to begin to use the Vermont Framework of Standards and Learning Opportunities across all grades. We began to train teachers in an instructional design process, before the framework had even been adopted by the State Board of Education. This proved to be both a blessing and a curse. Some teachers jumped right into the fray, while others seemed overwhelmed by the enormity of the task before them. We realized from a systems perspective that we had to regroup.

As a leadership team, we began to ask tough questions regarding how we would focus our work across the system, in order to ensure the success of all our students. The first necessary step seemed almost obvious. The district administrative team agreed to take on the task of developing a comprehensive curriculum improvement process to ensure standards-based instructional continuity across all levels of our PreK-12 system. Toward that end, the Assistant Superintendent began the process of research and review. He attended conferences that focused on Curriculum Development, reviewed professional literature, and bench marked with other Vermont districts to identify "Best Practices" that would lead to improvement in student learning. The administrative team and a Teacher Leader (VISMT Teacher Associate), met on a weekly basis and began to articulate a series of questions the district would have to address.

Questions included the following:

- What was our student performance data (from the State Comprehensive Assessment System) telling

us? Were our students meeting the standards?

- What were our instructional weaknesses, what were our strengths?
- What was actually being taught in our classrooms versus what is listed as our curriculum?
- What were our past practices regarding curriculum development? As a matter of practice, did we gather meaningful input from our constituents regarding priority areas?
- What is our primary goal for curriculum development? Is it directly linked to increased student performance?
- Is the articulated curriculum viewed as a PreK-12 continuum?
- How will we evaluate our efforts, who should conduct the curriculum evaluation? How will we manage the entire process?
- What procedures will we develop to insure that the commercially published materials that we purchase, are linked to our standards based reform effort? What criteria will we use to make these important decisions?
- How will we insure that assessment and evaluation are an ongoing part of the process?
- What training and support will staff members need in order to make changes in their instructional delivery?

***As we asked the tough questions, it became more and more apparent that we needed a carefully developed curriculum improvement process to ensure that we would end up, where we now knew we needed to be.***

As we asked the tough questions, it became more and more apparent that we needed a carefully developed curriculum improvement process to ensure that we would end up, where we now knew we needed to be. Through ongoing dialogue, we honestly critiqued and identified the steps that had been missing in our past efforts. In response to our findings, the Assistant Superintendent proposed a four phase curriculum improvement cycle that included the following stages:

- Planning,
- Development,
- Implementation
- Evaluation.

This improvement cycle was adapted from a model outlined by Dr. Ralph Jasparro at the Hampshire Collaborative Conference entitled Restructuring Curriculum for Student Achievement.

***It also became apparent, that we needed to think about our organizational structure, composition of committees and a curriculum improvement plan that would be manageable and feasible.***

As the leadership team (Administrators and Teacher Leader) began to develop and adapt a process that would make sense for our district, it became very obvious that our curriculum evaluations had not been thorough enough in the past. We were not utilizing all the implementation information, to update and revise our instructional program. It also became apparent, that we needed to think about our organizational structure, composition of committees and a curriculum improvement plan that would be manageable and feasible.

We decided to seize the opportunity at hand. As a team we concluded that the "time was right" to get all academic subject areas into the process. We are now grappling with several issues.

- As this article is being written, committees are now being formed which combine and cluster "The Specials".
- As we looked at our committee structure, we realized that elementary teachers could not serve on multiple committees and be implementing several new programs at the same time.
- We will continue to build trust among our professional staff to encourage and support their colleagues as they make some choices for their grade level teams across curriculum areas.
- At the middle school and high school level, academic departments structures will be utilized to ensure broad faculty involvement and acknowledge the culture of the schools.

- Since our goal is to develop a PreK-12 continuum, we are utilizing a three tiered infra-structure: a building based, district based, and an overarching umbrella group (PreK-12 Council) will help insure curriculum continuity and alignment. Each of the district committees will have representatives form the elementary, middle, and high school faculty, a necessity to encourage and foster a PreK-12 continuum.

As we continue this curriculum improvement journey, we will keep our eye on our primary target "increased student achievement for all of our students". We are willing to keep you informed of our progress and invite you to do the same.

*Bonnie Tuscany — Fifth Grade Teacher,*
*Morristown Elementary, VISMT Teacher Associate*

*Bob Stanton — Assistant Superintendent,*
*Lamoille South S.U.*

# The Vermont Standards And Curriculum Development:

## A High School And Supervisory Union Challenge

In the summer of 1996, the high school science faculty was charged with reviewing their curriculum in light of the recent adoption of Vermont's Framework of Standards and Learning Opportunities. The faculty, by and large, was already committed to the Standards. Members were part of the team that created the Science, Math, and Technology standards and were part of the group that developed the Vermont Science Assessment. So little preliminary preparation, such as introductory sessions, was required. This is likely not the case in many Vermont high schools.

As discussions ensued about how the science department would develop a standards-based program, teachers raised some fundamental organizational questions. Even though their school had several examples of interdisciplinary programs, the overall structure was course-based. That is, most students followed the traditional sequence of biology, chemistry, physics and, for many, AP biology. The teachers surmised that to move to a standards-based curriculum would take some alteration of their fundamental structure. After much discussion, the faculty targeted a unique reorganization by using the science content standards as their organizational structure. All courses will fall under one of three "domains": Space, Time and Matter; The Living World; or The Universe, Earth, and the Environment.

***The teachers surmised that to move to a standards-based curriculum would take some alteration of their fundamental structure.***

The new curriculum was designed so that students will focus on courses that distribute their exposure to all three areas during the first two years. They must take at least one semester within each "domain" during their first two years in high school. During this time they will be assessed in order to understand their ability to meet the standards. After completing this initial requirement, students will be free to take courses in any of the domains. Significantly, achievement of the standards will become a graduation requirement in addition to other more traditional requirements.

As the teachers planned these changes, they identified lack of consistency in the background of the incoming ninth grade students as an issue. Some came from sending schools that emphasized physical science, while others entered high school with greater exposure to biology. Some students emerged from a hands-on program while others came from more traditional settings. For students to achieve the standards in order to graduate, they would need to be involved in standards-based articulated science programs long before entering high school. This led the high school science teachers to propose assessing incoming ninth grade students according to the standards. At this point, the high school teachers decided that they needed the involvement of the sending school science teachers if they were to create such an assessment tool.

After a series of meetings with teachers from the four sending schools, it became apparent that the teachers were at all levels of understanding with regard to standards-based curriculum and assessment. Some schools were heavily involved with examining their own curriculum in order to have it more closely align with standards, while others had done little or no work in this regard. Of course, this complicated the situation even more since some of the sending schools had already embarked on an "alignment" project of their own, making it even more difficult to change their curriculum direction to meet the needs at the supervisory union level.

At this point, the effort sputtered along for a number of months. Since the initiative for change had emerged from the high school science department members, leadership of the effort fell on them by default. The need for coordination and communication, however, was a supervisory union need. The science department had had no charge from the supervisory union to do this work, and the critical factors of time and coordination for such a broad effort were in short supply. Fortunately, the individual administrations in each school worked to support the effort.

In the early spring of 1998, a meeting of the high school science faculty and teams of science teachers from each of the sending schools was convened at an off-campus location. In order to gain a better grasp of the curricular variations from school to school, the group followed a simple process in which they compared their existing science curriculum to the Vermont Standards. They were asked to simply identify those standards and accompanying "evidence" statements that they felt were adequately addressed by their existing curriculum.

***Every faculty team, including the high school, discovered that even within their own school there is great disparity in the alignment between the curriculum and the standards.***

The sending schools discovered that their students were entering high school with wide disparity in backgrounds. But a more important aspect emerged from this exercise. Every faculty team, including the high school, discovered that even within their own school there was great disparity in the alignment between the curriculum and the standards. Furthermore, since students follow different curriculum paths at the high school or are assigned to different "teams" in middle school, even with proper alignment of curriculum to the standards, different curricula is followed within the schools.

Looking ahead, with an understanding of past challenges, it is apparent that leadership and coordination of this initiative is essential if it is to succeed. The example described here is representative of the issue facing every supervisory union in Vermont. It is a significant "systems" issue that applies everywhere and must be solved if Vermont schools are to truly integrate a standards-based K-12 curriculum. In the words of one of the participants, "The problems are part of the solution." By observing where the problems lie, we can see the path to solving them.

Clearly, there has to be some "curriculum authority" for this initiative. An incredible amount of work was done through a grassroots effort, but if the ultimate product is to function at a supervisory union level, some authority for making decisions has to be assigned to the curriculum development committee. That authority can only be granted by the local school boards.

This project illustrates the complex array of issues and problems facing Vermont's districts in their efforts to provide a comprehensive system of curriculum, instruction, and assessment. While the process is extremely difficult for "self-contained" school districts, it is even more challenging for supervisory unions.

# Resources

## Table of Contents

# Morristown School District:

## *Curriculum Improvement Cycle*

**Process for curriculum planning, development, implementation and evaluation**

**BBCC**- *Building Based Curriculum Committee*

**DWCC**-*District Wide Curriculum Committee*

**PK12SC**-*PK12 Steering Committee*

| Curriculum Content Area | Forms | Completion Date |
|---|---|---|
| **PLANNING** | **Form P** | |
| **1.0 Establish a structure and process - MSD Admin.** | Section 1.0 | |
| 1.1 Identify committees' members, clarify roles and responsibilities | | |
| 1.2 Determine and provide optimum training for committees | | |
| 1.3 Use district format for curriculum guides | In progress | |
| 1.4 Develop timetable for phases of district curriculum management plan | See Curriculum Management Plan | |
| 1.5 Each BBCC identifies a representative to serve on the DWCC | | |
| | | |
| **2.0 Curriculum Audit - BBCC** | Section 2.0 | |
| 2.1 Articulate the presently "taught" curriculum | | |
| 2.2 Use Vermont Framework to analyze, align curriculum | | |
| 2.3 Analyze and identify gaps and overlaps in instruction in relation to the Vermont Framework of Standards and Learning Opportunities | | |
| | | |
| **3.0 Student Performance Audit and Analysis - BBCC** | Section 3.0 | |
| 3.1 Gather standards-based data and other pertinent data from the local and state comprehensive assessment plan | | |
| 3.2 Analyze the data to determine what students are learning and not learning in relation to the Vermont Standards | | |
| 3.3 Use the data analysis to identify strengths and weaknesses in curriculum and instructional practices and report findings | | |
| 3.4 Use the data analysis to identify strengths and weaknesses of district assessment plan and report findings | | |

| Curriculum Content Area | Forms | Completion Date |
|---|---|---|
| **DEVELOPMENT** | Form D | |
| **4.0 Research and Dissemination - BBCC** | Section 4.0 | |
| 4.1 Review standards-based curriculum documents, published materials, and instructional practices that align with Vermont and National Standards | | |
| 4.2 Disseminate information about effective, research-based instruction to the appropriate stakeholder groups | | |
| | | |
| **5.0 Expectations and Benchmarks - BBCC** | Section 5.0 | |
| 5.1 Review guiding principles for improving learning outcomes | | |
| 5.2 Make preliminary decisions regarding levels where standards will receive major emphasis | | |
| 5.3 Make preliminary decisions regarding grade level/course performance benchmarks | | |
| 5.4 Prepare draft of standards-based curriculum by level: PK-5, 6-8, 9-12 | | |
| 5.5 Develop a preliminary action plan targeted at raising student performance | | |
| | | |
| **6.0 Coordination and Adoption - DWCC** | Section 6.0 | |
| 6.1 Coordinate the work of BBCC verifying alignment and continuity across the system | | |
| 6.2 Review recommendations for instructional materials in the context of alignment and continuity | | |
| 6.3 Recommend elements of district-wide action plan to raise student performance | | |
| 6.4 Meet with PK12SC to review its findings and recommendations | | |
| 6.5 With PK12SC approval and endorsement participate in presentation of PK-12 curriculum guide, relevant standards-based assessment results and recommendations of action plans as part of the Morristown School District curriculum adoption process | | |

| Curriculum Content Area | Forms | Completion Date |
|---|---|---|
| **IMPLEMENTATION** | Form I | |
| **7.0 Standards-Based Learning Environments MSD Admin.** | Section 7.0 | |
| 7.1 Follow the articulated curriculum and strategies for raising student performance | | |
| 7.2 Align and optimize scheduling, staffing, grouping, best practices in support of standards-based curriculum, teaching and learning | | |
| 7.3 Ensure that all educational materials for classroom instruction will support the district articulated curriculum | | |
| 7.4 Align and provide professional development and supervision to support effective teaching and learning practices | | |
| **EVALUATION** | Form E | |
| **8.0 Curriculum Monitoring and Evaluation - BBCC** | Section 8.0 | |
| 8.1 Findings are reported to the DWCC and the PK12SC | | |
| 8.2 Return to reflection and analysis stages of curriculum cycle to ensure improved student performance | | |
| | | |
| **9.0 Curriculum Monitoring and Evaluation for System-PK12SC** | Section 9.0 | |
| 9.1 Will review student performance results and curriculum monitoring audits on an annual basis from a system perspective | | |
| 9.2 Report the findings to the Morristown School Directors and the Morristown Community | | |

# Linking Vermont Science Standards to National Standards

"Where can I find more information about the science content standards in Vermont's Framework of Standards and Learning Opportunities?"

Many teachers are not aware that almost all of Vermont's science standards were drawn from three documents outlining national standards in science, documents that provide a wealth of important supporting information. Below you will find cross references between Vermont's Framework and those documents.

The first national standards in science, Benchmarks for Science Literacy (**BM**) (also sometimes referred to as Project 2061), was published by the American Association for the Advancement of Science (AAAS) in 1993 following the national report "Science for All Americans" which was later published as a book of the same name by James Rutherford and Andrew Ahlgren. The report recommended "that schools do not need to be asked to teach more and more content, but rather to focus on what is essential to scientific literacy, and to teach it more effectively."

Benchmarks spelled out specific content standards and made recommendations based on the latest research in science education about when and how the content should be addressed. The recommendations of developmental ages, and changes in pedagogy to address them were based on the latest findings in learning theory and research in the '70's and '80's that showed that large percentages of high school and college graduates do not understand fundamental science concepts despite years of science instruction.

In 1996 the National Academy of Science published a second set of national standards, The National Science Education Standards (**NSES**). Fortunately there is a great deal of similarity between the recommendations of the two publications. A joint commission supported by both organizations concluded that there was approximately 85% overlap between the standards in both documents.

The Vermont Framework of Standards and Learning Opportunities published in 1996 drew heavily on Benchmarks, its predecessor Science for All Americans, and upon the National Science Education Standards. Whereas the Vermont Framework is notably concise there is a wealth of information on the standards and "best practices" in the national standards and in references within them to additional publications. Although topics in the Vermont Framework may seem largely familiar, such as the atomic model, the national standards, at times, make important recommendations for changes in the timing and the approach to teaching them. It is strongly recommended that teachers and administrators who are responsible for leading the change to a standards-based science curriculum in their schools become very familiar with the documents on which the Vermont Framework is based.

The following table cross-references the science evidences in the Vermont Framework with the national standards from which they were drawn. Although a single page or two in the national standards may be referenced for a particular evidence, in order to fully understand the recommendation it is important to read the relevant surrounding passages.

For example, in the grades 5-8 evidence in Space Time and Matter bb. which deals with describing and modeling the phenomena of chemical reactions with reference to elements and compounds, the cross reference table highlights the specific page(s) on which the standard (evidence) is to be found: NSES 154 and BM 78 and 79. But for a thorough understanding of the developmental and pedagogical issues involved in teaching a conceptual understanding of the structure of matter, the surrounding pages, NSES pp.149-155, BM pp. 75-80, and Science for All Americans pp. 42-44 are very important to read.

Secondary sources of information can also be helpful in clarifying the Vermont Standards and the national standards. Frameworks of other states constitute one source. States with greater resources, such as California, have produced extensive frameworks based in part or wholly on national standards. Such frameworks can often be found through a web search of state departments of education. They can also be accessed through two CD ROMs from the Eisenhower National Clearinghouse for

Mathematics and Science Education, *Tools for Discussion: Attaining Excellence Through TIMSS and Making Schools Work for Every Child* (see **Useful Resource Materials**).

Another secondary source that can elaborate on and clarify Vermont's standards are the published science programs based strictly on national standards. The best of such programs are ones written and published in the last five years through grants from the National Science Foundation. Interested persons are welcome to visit VISMT's offices to review any of these materials. Please call in advance to make arrangements, (802)-244-8768.

## Inquiry, Experimentation and Theory

### 7.1 Scientific Method

a. NSES - 122

b. NSES - 122

c. NSES - 122

d. NSES - 122

e. NSES - 122

f. NSES - 145

g. NSES - 122, 148

i. BM - 15

aa. NSES - 145

bb. NSES -175

cc. NSES - 145, BM - 13

dd. NSES - 145

gg. NSES - 148, 145

ii. BM - 15

aaa. NSES - 175

bbb. NSES - 145

ddd. NSES - 175

ggg. NSES - 175

### 7.2 Investigation

a. NSES - 122, 145

b. NSES - 122

d. NSES - 122

aa. NSES - 145

bb. BM - 11

i. (see 7.4)

### 7.3 Theory

a, b, c. BM - 6, 10-11; NSES - 123

aa, bb, cc. BM - 7, 12; NSES - 148

aaa. BM - 8, 13; NSES - 176

### 7.4 History of Science, Mathematics and Technology

a. BM - 240, 250, 252, 257, 259; NSES - 141, 171

aa. BM - 241, 243, 245, 246, 248, 251, 253, 254-255, 259; NSES - 201

### 7.5 Roles and Responsibilities

a. NSES - 67

aa. NSES - 169-170

aaa. NSES - 199

## Physical Science (Space, Time and Matter)

### 7.12 Matter, Motion, Forces, and Energy

a. NSES - 127; BM - 76-77

b. NSES - 127; BM- 78

c. BM - 77

d. NSES - 127; BM - 89

e. NSES - 127; BM - 83-84

f. NSES - 127; BM - 94

aa. NSES - 154; BM - 78-79

bb. (see aa.)

cc. unique to Vermont.

dd. NSES - 154; BM - 90

ee. NSES - 155; BM - 85

ff. NSES - 180; BM - 95

aaa. NSES - 179; BM - 80

bbb. NSES - 178; BM - 80

ccc. unique to Vermont.

ddd. NSES - 179-180; BM - 91-92

eee. NSES - 180; BM - 88

fff. NSES - 180; BM - 96-97

## The Living World

### 7.13 Organisms, Evolution, and Interdependence

a. NSES - 129; BM - 102,103,110,111

b. BM - 102, 103

c. NSES - 129; BM - 116

d. BM - 123

aa. NSES - 156; BM - 104,112

bb. BM - 104

cc. NSES - 157-8; BM - 117

dd. NSES - 158; BM - 124

aaa. NSES - 184-5; BM - 105, 113-114

bbb. NSES 185; BM - 105

ccc. NSES - 186; BM - 117

ddd. NSES - 185; BM - 125

### 7.14 The Human Body

a. BM - 142

b. BM - 136

BM - Benchmarks for Science Literacy

NSES - National Science Education Standards

c. BM - 144

d. BM - 132

aa. BM - 132, 133, 134

bb. BM - 137

cc. BM - 145

dd. BM - 133

aaa. BM - 134

bbb. BM - 138

ccc. BM - 146

ddd. BM - 134

## The Universe, Earth and Environment

### 7.15 Theories, Systems and Forces

a. NSES - 134; BM - 72

b. NSES - 134; BM - 72

c. NSES - 134; BM - 67-68, slightly- 62-63

d. NSES - 160; BM - 62-63

e. NSES - 140; BM - 69

aa. NSES - 159-161; BM - 73

bb. NSES - 159-161; BM - 73

cc. NSES - 159-161; BM - 68- 69, 73

dd. NSES - 159-161; BM - 68- 69, 64, 94-95

ee. NSES - 168; BM - 69, 73

f. BM - 240, 241, 243, 245

aaa. NSES - 189-190; BM - 74

bbb. NSES - 189-190; BM - 74

ccc. NSES - 189-190; BM - 96- 97, 70

ddd. NSES - 189-190; BM - 65

eee. NSES - 198

fff. BM - 240, 241, 243, 245

BM - Benchmarks for Science Literacy

NSES - National Science Education Standards

# Science Standards Mapping Tool

**Scoring:** *4 = Standard is thoroughly addressed and assessed*
*3 = Standard is thoroughly addressed*
*2 = Standard is addressed somewhat*
*1 = Standard is not addressed*

| | Score | Comments: How is standard addressed? |
|---|---|---|
| **Inquiry, Experimentation and Theory**<br>Uses scientific methods to describe, investigate and explain phenomena | | |
| Designs and conducts a variety of his/her own investigations and projects. | | |
| Understands the nature of mathematical, scientific and technological theory | | |
| Understands the history of science, math and technology | | |
| Analyzes the roles and responsibilities of scientists, mathematicians and technologists | | |
| **Systems**<br>Analyzes and understands living and non-living system as collections of interrelated parts and interconnected systems | | |
| **Space, Time and Matter**<br>Understands forces and motions, the properties and composition of matter and energy sources and transmission | | |
| **The Living World**<br>Understands characteristics of organisms, sees patterns of similarity and differences among living organisms | | |
| Understands the role of evolution and recognizes interdependence of all systems that support life | | |
| Understands human body in terms of heredity, body systems, development and interaction with the environment | | |
| **Universe, Earth and Environment**<br>Understands earth, environment, solar system and universe in terms of characteristics, forces that shape and effect them and current theories regarding their evolution | | |
| **Natural Resources**<br>Understand how natural resources are extracted, distributed, processed and disposed of | | |

R. Quinn, Walden School

# Published Curriculum Materials:

## *Supporting Implementation of Standards-Based SMT for all Vermont Students*

The following section is in response to the question: *What materials are currently available to schools which align with National Standards and Vermont's Framework of Standards and Learning Opportunities?* VISMT has identified some materials that align with specific content standards, but would like local teachers, parents, students, and community to look at, pilot, and select materials which clearly meet the needs of their schools and students. Curriculum materials which are consistently used from one grade to the next create a continuum of learning for students with greater likelihood of addressing all the science areas within grade level clusters.

VISMT's website http://www.vismt.org is an excellent resource for learning more about the programs listed below. From the VISMT homepage click on **Program Areas**, then click on **Curriculum**. The site contains detailed reviews of the programs, curriculum costs, and more. It lists the companies and the information needed in order to contact them for sample copies, etc. If you would like to talk with teachers who are currently implementing the programs, the web site will also supply this information as well as many other vital links to education resources. It is a continually improving and expanding site providing the most up to date information on science, math, and technology
education in Vermont.

If you do not have World Wide Web access, please email Gerrie Denison at denisong@quark.vsc.edu or phone (802) 244-8768 and she will provide you with copies of the information on the web site.

### INQUIRY, EXPERIMENTATION, AND THEORY

**Scientific Method - Standard 7.1** Students use scientific methods to describe, investigate, and explain phenomena:

**Investigation - Standard 7.2** Students design and conduct a variety of their own investigations and projects.

Specific curricula materials are not listed here for Standard 7.1 or 7.2 because ALL of the materials listed below address these standards to various degrees. For more complete information on a specific curricula's alignment with these standards, or for detailed reviews of the materials in question, visit the VISMT website (http://www.vismt.org) or if you do not have World Wide Web access, please email Gerrie Denison at denisong@quark.vsc.edu or phone (802) 244-8768. In addition, as teachers we need to consciously provide specific student-driven investigations which enhance a student's ability to design and conduct investigations and projects and to engage in more questioning, hypothesizing, testing, experimenting, etc.

## SYSTEMS

**Analysis - Standard 7.11** Students analyze and understand living and non-living systems (e.g., biological, chemical, electrical, mechanical, optical) as collections of interrelated parts and interconnected systems

**K - 4**

FOSS-Insects Module, Air & Weather, Human Body
Science for Life and Living-Myself & My World, Order, Change, Systems
*DASH-Grades K-4
Insights-Habitats Module
STC-Comparing & Measuring

**5 - 8**

Science for Life and Living-Energy, Balance
FOSS-Variables
STC-Machines & Inventions
Prime Science-Grades 6,7,8
Facets-Investigating Buildings
*DASH-Grades 5,6
Integrated Science-Grades 6,7,8
Science Interactions-Grades 6,7,8

**9-12**

Prime Science-Grades 9,10
Active Physics
Science Links-Grade 9

## PHYSICAL SCIENCE (SPACE, TIME, AND MATTER)

**Matter, Motion, Forces & Energy - Standard 7.12** Students understand forces and motion, the properties and composition of matter, and energy sources and transformations.

**K - 4**

FOSS-Solids & Liquids, Balance & Motion, Air & Weather, Physics of Sound, Water, Magnetism & Electricity
STC-Solids & Liquids, Chemical Tests, Electric Circuits
Science for Life and Living-Myself & My World, Order, Change, Systems
*DASH-Grades K-4

**5 - 8**

FOSS-Mixtures & Solutions, Levers & Pulleys
STC-Magnets & Motors, Floating & Sinking, Food Chemistry
Science for Life and Living-Energy
Prime Science-Grades 6,7,8
Facets-Food Substitutes
Integrated Science-Grades 6,7,8
*DASH-Grades 5,6
Insights-Structures

**9-12**

Prime Science-Grades 9, 10
Active Physics
Science Links-Grade 9

## THE LIVING WORLD

**Organisms, Evolution, & Interdependence - Standard 7.13** Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life.

**K - 4**

FOSS-New Plant Module, Structures of Life

STC-Organisms, The Life Cycle of Butterfly, Plant Growth & Development, Animal Studies

Science for Life and Living-Myself & My World, Order, Change, Systems

*DASH-Grades K-4

Insights-Habitats Module

**5 - 8**

STC-Microworlds, Experiments with Plants, Ecosystems

Middle School Science & Technology-Energy, Balance

Facets-Weather & Health, Acid Rain, Sunken Ship

Science Interactions-Grades 6,7,8

*DASH-Grades 5-6

FOSS-Food & Nutrition

Prime Science-Grades 6,7,8

**9-12**

Insights in Biology-Traits & Fates, What on Earth, The Matter of Life

Science Links-Grade 9

Prime Science-Grades 9, 10

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**The Human Body - Standard 7.14** Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body.

**K - 4**

Science for Life and Living-Myself & My World, Order, Change, Systems

*DASH-Grades K-4

FOSS-Human Body

**5 - 8**

Middle School Science & Technology-Energy, Balance

Facets-Keeping Fit, Growing Older

Science Interactions-Grades 6,7,8

*DASH-Grades 5,6

Prime Science-Grades 6,7,8

FOSS-Food & Nutrition

STC-Food Chemistry

**9-12**

Insights in Biology-The Matter of Life, Traits & Fates, Blueprints of Infection, What on Earth

Active Physics

Science Links-Grade 9

Prime Science-Grades 9,10

## THE UNIVERSE, EARTH, AND ENVIRONMENT

**Theories, Systems, & Forces - Standard 7.15** Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, and the theories that currently explain their evolution.

**K - 4**

FOSS-Pebbles, Sand & Silt, Air & Weather, Human Body, Earth Materials, Water

STC-Weather, Land & Water, Rocks & Minerals

Science for Life and Living-Myself and My World, Order, Change, Systems

Insights-Habitats Module

*DASH-Grades K-4

**5 - 8**

FOSS-Environments, Levers & Pulleys, Landforms, Solar Energy

Facets-Earthquakes, Shifting Coastlines, Shrinking Farmlands

Middle School Science & Technology-Energy, Balance

Prime Science-Grades 6,7,8

Science Interactions-Grades 6,7,8

Integrated Science-Grades 6,7,8

*DASH-Grades 5,6

**9-12**

Prime Science-Grades 9,10

Active Physics

Science Links-Grade 9

## DESIGN AND TECHNOLOGY

**Natural Resources - Standard 7.16** Students understand how natural resources are extracted, distributed, processed, and disposed of.

| K - 4 | 5 - 8 | 9-12 |
|---|---|---|
| Science for Life and Living-Myself & My World, Order, Systems | Middle School Science & Technology-Energy, Balance<br>Prime Science-Grades 6,7,8<br>Facets-Food From our Land<br>Integrated Science-Grades 6,7,8 | Prime Science-Grades 9,10<br>Active Physics-Grade 9 |

**Technological Systems - Standard 7.17** Students apply knowledge and understanding of technological systems to respond to a variety of issues.

| K - 4 | 5 - 8 | 9-12 |
|---|---|---|
| Science for Life and Living-Myself & My World, Order, Systems | Middle School Science & Technology-Energy, Balance<br>Prime Science-Grades 6,7,8<br>Integrated Science-Grades 6,7,8 | Prime Science-Grades 9, 10<br>Active Physics<br>Science Links-Grade 9 |

**Outputs & Impacts - Standard 7.18** Students understand that people control the outputs and impacts of our expanding technological activities in the areas of communication, construction, manufacturing, power and transportation, energy sources, health technology, and biotechnology.

| K - 4 | 5 - 8 | 9-12 |
|---|---|---|
| Science for Life and Living-Systems | Middle School Science & Technology-Energy, Balance<br>Prime Science-Grades 6,7,8<br>Integrated Science-Grades 6,7,8 | Prime Science-Grades 10, 11<br>Active Physics<br>Science Links |

**Designing Solutions - Standard 7.19** Students use technological/engineering processes to design solutions to problems.

| K - 4 | 5 - 8 | 9-12 |
|---|---|---|
| Science for Life and Living-Systems | Prime Science-Grades 6,7,8<br>Integrated Science-Grades 6,7,8<br>Facets<br>STC-Models & Designs<br>Insights-Structures | Prime Science-Grades 10, 11<br>Active Physics<br>Science Links-Grade 9 |

*DASH is a complete K-6 program that addresses all standards

# Program Publishers

**Active Physics** (High School)
It's About Time

**Delta Science Modules (DSMII)** (Elementary)
Delta Education

**Developmental Approaches In Science, Health, and Technology (DASH)** (Elementary)
University of Hawaii

**Foundations And Challenges To Encourage Technology (FACETS)** (Middle School)
Kendall Hunt Publishing

**Full Option Science System (FOSS)** (Elementary)
Delta Education

**Insights** (Elementary)
Kendall Hunt Publishing

**Insights In Biology** (High School)
Kendall Hunt Publishing

**Integrated Science** (Middle School)
University of Alabama

**Middle School Science & Technology** (Middle School)
Kendall Hunt Publishing

**Prime Science** (grades 6-10)
Kendall Hunt Publishing

**Science & Technology For Children (STC)** (Elementary)
Carolina Biological Supply

**Science For Life And Living** (Elementary)
Kendall Hunt Publishing

**Science Interactions** (Middle School)
Glencoe/McGraw-Hill

**Science Links** (High School)
International Thompson Publishers

**Technology** (Middle and High School)
Glencoe/McGraw-Hill

*NOTE: To purchase materials or acquire review copies of materials, contact the individuals listed. These names and phone numbers are subject to frequent change. If you have trouble using the names or phone numbers, contact the publisher's customer information directly or visit VISMT's web site at http://www.vismt.org/publishers.html*

# Publishers/Contacts

**Carolina Biological Supply Company**
Contact: Gena Wofford
Phone: 1-800 227-1150 Ext. 5265
Web Address: www.carolina.com/STCpg.htm

**Decision Development Corporation**
Contact: Decision Development Corporation
Address: 2680 Bishop Drive, San Ramon, CA 94583
Phone: 1-800 835-4332
Fax: 1-510 830-0830
E-mail: ddc2000@aol.com
Web Address: www.ddc2000.com

**Delta Education**
Contact: Lisa Wood
Address: P.O. Box 915, Hudson, NH 03051
Phone: 1-978 433-9937 OR 1-800 258-1302
Fax: 1-978 433-6790
E-mail: majordomo@lists.mv.net
Web Address: www.delta-ed.com

**Glencoe/McGraw-Hill**
Contact: Richard Seefeldt
Phone: 1-800 297-4638 (access code: 17)
E-mail: RSGlencoe@Berk.com
Web Address: www.glencoe.com

**International Thompson Publishers: South-Western Publications**
Contact: Steven Foley (Biology)
Phone: 1-617 287-0205
Fax: 1-617 825-4825
E-mail: sfoley@swpco.com
Web Address: www.swpco.com
Contact: Cheryl Barnes (Mathematics)
Phone: 1-800 543-0487 Ext. 9110

**It's About Time**
Web Address: www.activephysics.com
Web Address: www.mathconnections.com
Contact: Chaim Durst
Phone: 1-888 698-8463
Web Address: www.itsabouttime.com

**University Of Alabama**
Contact: Chris Theriot
Address: University of Alabama/CCET, Box 870167, Tuscaloosa, AL 35487-0167
Phone: 1-800 477-8151
Web Address: www.ccet.ua.edu/ishome.htm

**University Of Hawaii**
Web Address: www2.hawaii.edu.crdg/science/dash/dash.html
Web Address: www2.hawaii.edu.crdg/science/fast.FAST.html
Phone: 1-800 799-8111
Web Address: www2.hawaii.edu/crdg/

# Sample Curriculum Format (Grade 7)

## The Living World

### VT Standard — Organisms, Evolution and Interdependence

**7.13** Students understand the characteristics of organisms...

This is evident when:

### Grade 7

### Field of Knowledge Evidence

aa. Identify, model...

bb. Identify and use...

cc. Describe, model, and explain the...

### Focus Questions

aa. What is Life?

*Identify...

bb. How are living things...

*Recognize...

*Explain the...

dd. What is an ecosystem?

### Assessment

Ideas/Resources/Extensions/Enrichment

Franklin Northwest Supervisory Union

# Useful Resource Materials

*Highlighted materials are highly recommended for a basic science curriculum library.*

**I. Laying the Groundwork**
**II. Research and Development**
**III. Curriculum Implementation**
**IV. Monitoring and Revising**

| I | II | III | IV | |
|---|---|---|---|---|
| ★ | ★ | ★ | | "Aligning and Articulating Standards Across the Curriculum" (Science). North Central Regional Educational Laboratory (NCREL). www.ncrel.org/sdrs/areas/issues/content/cntareas/science/sc400.html |
| ★ | ★ | ★ | | *ASCD Curriculum Handbook* (Science; Section 5). (1995). Alexandria, Virginia: Association for Supervision and Curriculum Development. 703-549-9110 |
| | | | ★ | *Equity & Excellence: Action Planning Guide.* (1998). Montpelier, VT: Vermont Department of Education. |
| ★ | ★ | | | *Benchmarks for Science Literacy, Project 2061.* American Association for the Advancement of Science. (1993). New York: Oxford University Press. |
| | ★ | ★ | | "The Case for Authentic Assessment." Grant Wiggins. (1990). *ERIC Digest.* Washington, DC: American Institute for Research and ERIC Clearinghouse on Tests, Measurement, and Evaluation. |
| ★ | ★ | ★ | | *Connections Across Cultures: Inviting Multiple Perspectives into Classrooms of Science, Technology, Math and Engineering.* Charlotte Behm. Pac-Tec Project 1996: Santa Clara, CA: Mission College Printing Department |
| | | ★ | | *Designing Professional Development for Teachers of Science and Mathematics.* Susan Loucks-Horsley, et al. (1998). National Institute for Science Education; Corwin Press. |

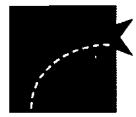
| I | II | III | IV | |
|---|---|---|---|---|
| ★ | | | | *Developing a Quality Curriculum.* Allan Glatthorn. (1994). Alexandria, Virginia: Association for Supervision and Curriculum Development. 703-549-9110 |
| | ★ | ★ | ★ | *Designing a Sustainable Standards-based Assessment System.* Don Burger. Mid-continent Regional Educational Laboratory (McCREL). 303-337-0990 www.mcrel.org/products/noteworthy/donintro.html |
| ★ | | ★ | | *Elementary School Science for the '90's.* Susan Loucks-Horsley, et. al. (1990). Alexandria, Virginia: Association for Supervision and Curriculum Development. 703-549-9110 |
| | ★ | ★ | | *Eight Questions You Should Ask Before Implementing Standards-Based Education at the Local Level (#'s 6-8).* Mid-continent Regional Educational Laboratory (McREL). www.mcrel.org/products/eight/#6 |
| ★ | | ★ | | *In Search of Understanding: The Case for Constructivist Classrooms.* Jacqueline and Martin Brooks. Alexandria, Virginia: Association for Supervision and Curriculum Development. 703-549-9110 |
| | | | ★ | "A Look at Program Standards." Harold Pratt. (October 1995). *The Science Teacher.* 62,7:22-27. |

| I | II | III | IV | |
|---|---|---|---|---|
| ★ | | ★ | | "Minds of our Own" (Video). Takes up the question: Why don't even the brightest students truly grasp the science concepts they are taught? This compelling documentary dramatically demonstrates with examples from the classroom that assumptions about how children learn are simply not true. Annenberg/CPB Math & Science Collection. 800-965-7373 |
| ★ | ★ | | | National Science Education Standards. (1996). National Academy Press, 2101 Constitution Ave., N.W. Washington, DC 20418. 800-624-6242 |
| ★ | | | | *National Standards and the Science Curriculum: Challenges, Opportunities, and Recommendations.* Roger Bybee. Kendall Hunt Publishing Company 4050 Westmark Drive Dubuque, Iowa 52002. 800-770-3544 |
| ★ | ★ | ★ | ★ | *NSTA Pathways To the Science Standards-Guidelines for Moving Vision into Practice.* Available in Elementary, Middle, and High School Versions. National Science Teachers Association 1840 Wilson Boulevard, Arlington, Virginia 22201 |
| ★ | ★ | | | *Omnibus Guidelines: The Work Sampling System.* Rebus Planning Associates, Inc. Ann Arbor, Michigan 800-435-3085 |
| ★ | ★ | ★ | | *Performance Standards.* (1997). (Elementary, Middle, and High School Versions) New Standards, LRDC University of Pittsburgh |
| ★ | ★ | ★ | ★ | *The Principal as Curriculum Leader.* Allan Glatthorn. Alexandria, Virginia: Association for Supervision and Curriculum Development. 703-549-9110 |
| ★ | | ★ | | "Private Universe" (Video). Annenberg/CPB Math & Science Collection. 800-965-7373 |

| I | II | III | IV | |
|---|---|---|---|---|
| | | ★ | | "Professional Development for Math and Science." *ENC Focus for Mathematics and Science Education.* Vol. 4, Issue 4, 1997. Eisenhower National Clearinghouse. 800-621-5785 |
| ★ | | ★ | | *Resources for Science Literacy: Professional Development.* (1997). Project 2061. Oxford University Press, New York. |
| | ★ | | | *Resources for Teaching Elementary School Science.* National Science Resources Center, National Academy of Sciences. (1996). Washington, DC: Smithsonian Institution National Academy Press. |
| | ★ | | | *Resources for Teaching Middle School Science.* National Science Resources Center, National Academy of Sciences. (1996). Washington, DC: Smithsonian Institution National Academy Press. |
| | ★ | | | *Review of Instructional Materials for Middle School Science.* National Science Foundation Directorate for Education and Human Resources, Division of Elementary, Secondary, and Informal Education. (October 1996). |
| | ★ | | | *Science Curriculum Resource Handbook: A Practical Guide for K-12 Science Curriculum.* D. W. Cheek, R. Briggs, and R.F. Yeager. Corwin Press. 805-499-9774 |
| | | ★ | | *Science Educators Guide to Assessment.* Rodney Doran, Fred Chan, and Pinchas Tamir. (1998). National Science Teachers Association. The book covers both student and overall program assessment. |
| ★ | | | | *Science for All Americans.* James Rutherford and Andrew Ahlgren. (1990). New York: Oxford University Press. |
| ★ | | ★ | | *Science for All Children: A Guide to Improving Elementary Science Education in your School District.* National Science Resources Center. (1997). National Academy Press. |

| I | II | III | IV | |
|---|---|---|---|---|
| ★ | ★ | | | *Science Matters: Achieving Scientific Literacy.* Robert Hazen & James Trefil. (1996). National Science Teachers Association. |
| | ★ | | | *Selecting Standards-based SMT Teaching Materials.* Vermont Institute for Science, Math, and Technology (VISMT) PO Box 310, Waterbury Ctr., VT 05677 802-244-8768 |
| | | ★ | | *Student-Centered Classroom Assessment.* Richard J. Stiggins. (1997). Prentice Hall. |
| ★ | ★ | | | *The Systematic Identification and Articulation of Content Standards and Benchmarks.* John S. Kendall and Robert J. Marzano. (1994). Mid-continent Regional Educational Laboratory (McREL) Aurora, CO 80014 303-337-0990 |
| ★ | ★ | ★ | | *Thoughts and Deeds: Equity in Mathematics and Science Education* Nancy Kreinberg and Ellen Wahl. 1997 Washington D.C., American Association or the Advancement of Science. |
| | ★ | | | "Using Children's Literature in Math and Science." *ENC Focus for Mathematics and Science Education.* Vol. 4, Issue 5, 1997. Eisenhower National Clearinghouse. 800-621-5785 |
| | ★ | | | *VeeOne.* http://www.floodbrook.k12.vt.us/veeone/starter.html |
| ★ | ★ | | | *Vermont Framework of Standards and Learning Opportunities.* Montpelier, VT: Vermont Department of Education. |
| | ★ | | | *Vermont Science Assessment Blueprint.* Vermont Institute for Science, Math, and Technology (VISMT) P.O. Box 310, Waterbury Ctr., VT 05677 802-244-8768 |
| ★ | | ★ | | *What We Know About Science Teaching and Learning.* Mid-continent Regional Educational Laboratory (McREL) Aurora, CO 80014 303-337-0990 |

| I | II | III | IV | |
|---|---|---|---|---|
| | | | | **Samples of Curricula** |
| ★ | | | | *Tools for Discussion: Attaining Excellence Through TIMSS* and *Making Schools Work For Every Child* ENC Eisenhower National Clearinghouse for Mathematics and Science Education. Ohio State University, Columbus, Ohio. These CD-ROMs can help educators access the wealth of information available at ENC. Some state frameworks, easily accessible using the CD-ROMs, are so comprehensive as to constitute, for the most part, state curriculum. They can be helpful as examples of curricula, showing how different state teams articulated the national standards by grades. |
| | ★ | | | Franklin Northwest Supervisory Union K-6 Science Curriculum. c/o Superintendent Bill Williams, 802-868-4967 |
| | ★ | | | Windsor K-6 Science Curriculum c/o Sheryl Watson, 802-674-2310 |
| | | | | **Science Consultants** |
| ★ | ★ | ★ | | For a current list of independent science consultants contact VISMT, 802-244-8768 |
| ★ | ★ | ★ | ★ | VISMT Teacher Associates. Contact VISMT, 802-244-8768 |
| ★ | ★ | ★ | ★ | Christa McAuliffe Science Fellows. Contact Tim Flynn at the Vermont Department of Education, 802-828-5129 |



The Vermont Institute for Science, Math and Technology (VISMT) was established in 1992 as a nonprofit organization to implement a Statewide Systemic Initiatives grant from the National Science Foundation. In 1998 the grant was renewed for a second 5-year period. The goal of the project is to dramatically transform science, math and technology education for all Vermont students.

One of VISMT's primary areas of work has been with teachers, both in providing and assuring strong professional development and in supporting their efforts to improve education in Vermont, school by school and community by community. The suggestions and stories in this booklet reflect some of the experiences and learnings of Vermont teachers as they have worked toward aligning curriculum with the standards.

VISMT is grateful to its staff, Teacher Associates, and many partnership schools for their help and recommendations which have made this booklet possible.

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